

WHAT IS CLAIMED IS:

1 1. A double-gimbaled micromachined mirror structure for parallel-plate
2 electrostatic operation, said mirror structure comprising:
3 a frame;
4 a mirror;
5 a gimbal around said mirror;
6 a plurality of hinge structures at four positions on said gimbal, a first pair of
7 said hinge structures connecting said mirror to said gimbal and a second pair of said hinge
8 structures connecting said frame to said gimbal, said hinge structures permitting motion
9 substantially only normal to said mirror and wherein adjacent each element of said second
10 pair is a tab extension from said mirror for serving as rotational displacement limitation; and
11 overhanging structure adjacent each of said four positions and disposed to
12 confront each said tab extension to limit rotational displacement of said mirror.

1 2. The apparatus according to claim 1 wherein said overhanging structure
2 and said mirror are maintained in sufficient differential in potential to permit detection of
3 contact of said overhanging structure and said mirror through detection of voltage change.

1 3. The apparatus according to claim 1 wherein said overhanging structure
2 and said mirror are maintained in sufficient differential in potential to permit detection of
3 contact of said overhanging structure and said mirror through detection of current change.

1 4. The apparatus according to claim 1 wherein said overhanging structure
2 and said mirror are maintained in equipotential.

1 5. The apparatus according to claim 1 wherein said detectable differential
2 is sufficiently small to inhibit arcing upon contact between said overhanging structure and
3 said mirror or gimbal.

1 6. The apparatus according to claim 1 wherein each of said first pair of
2 hinge structures includes a gimbal wraparound for serving as rotational displacement
3 limitation in confrontation with said overhanging structure.

1 7. The apparatus according to claim 1 wherein said overhanging structure
2 is disposed to provide a clear aperture at all design viewing angles of said mirror.

1 8. The apparatus according to claim 1 wherein said detectable differential
2 is sufficiently small to inhibit arcing upon contact between said overhanging structure and
3 said mirror or gimbal.

1 9. A double-gimbaled micromachined mirror structure for parallel-plate
2 electrostatic operation, said mirror structure comprising:

3 a frame;

4 a mirror;

5 a gimbal around said mirror;

6 a plurality of hinge structures at four positions on said gimbal, a first pair of
7 said hinge structures connecting said mirror to said gimbal and a second pair of said hinge
8 structures connecting said frame to said gimbal, said hinge structures permitting motion
9 substantially only normal to said mirror and wherein adjacent each element of said first pair
10 is a gimbal wraparound for serving as rotational displacement limitation; and

11 overhanging structure adjacent each of said four positions and disposed to
12 confront each said gimbal wraparound to limit rotational displacement of said mirror.

1 10. The apparatus according to claim 9 wherein said overhanging structure
2 and said mirror are maintained in sufficient differential in potential to permit detection of
3 contact of said substrate and said mirror through detection of voltage change.

1 11. The apparatus according to claim 9 wherein said overhanging structure
2 and said mirror are maintained in sufficient differential in potential to permit detection of
3 contact of said substrate and said mirror through detection of current change.

1 12. The apparatus according to claim 9 wherein said overhanging structure
2 and said mirror are maintained in equipotential.

1 13. The apparatus according to claim 9 wherein said detectable differential
2 is sufficiently small to inhibit arcing upon contact between said mirror and said overhang.

1 14. The apparatus according to claim 9 wherein near each element of said
2 second pair is a tab extension from said overhanging structure for serving as rotational
3 displacement limitation on said mirror.

1 15. The apparatus according to claim 1 wherein said overhanging structure
2 is disposed to provide a clear aperture at all design viewing angles of said mirror.

1 16. The apparatus according to claim 9 wherein said overhanging structure
2 is disposed to provide a clear aperture at all design viewing angles of said mirror.

1 17. The apparatus according to claim 1 wherein said overhanging structure
2 is disposed over said mirror and mounted on a flipped SOI handle structure.

1 18. The apparatus according to claim 9 wherein said overhanging structure
2 is disposed over said mirror and mounted on a flipped SOI handle structure.

1 19. The apparatus according to claim 1 wherein said overhanging structure
2 is disposed over said mirror and formed in a bevel etched by potassium hydroxide.

1 20. The apparatus according to claim 9 wherein said overhanging structure
2 is disposed over said mirror and formed in a bevel etched by potassium hydroxide.

1 21. The apparatus according to claim 1 wherein said overhanging structure
2 is disposed over said mirror and formed of a thinned silicon wafer.

1 22. The apparatus according to claim 9 wherein said overhanging structure
2 is disposed over said mirror and formed of a thinned silicon wafer.

1 23. The apparatus according to claim 1 wherein said hinge structures are
2 folded longitudinal gimbal hinge structures.

1 24. The apparatus according to claim 9 wherein said hinge structures are
2 folded longitudinal gimbal hinge structures.

1 25. The apparatus according to claim 1 wherein said folded longitudinal
2 gimbal hinge structures attached to the gimbal are recessed into the mirror.

1 26. The apparatus according to claim 1 wherein said mirror is round.